

TVET 360°: Empowering Politeknik Students through Lifelong Learning, Digital Technology, and Industry-Aligned Competency Development

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Abstract

This study is intended to examine the influence of lifelong learning attitudes and readiness to use digital technology on developing competencies in alignment with industrial demands among the student population at Politeknik Tuanku Syed Sirajuddin. Along with the efforts of the TVET institution to produce graduates ready to face the future, the ability of students to apply the knowledge and adapt to the ever-changing digital environment becomes increasingly important. The study is guided by three research questions: (1) To what extent do students demonstrate lifelong learning attitudes? (2) What is the level of students' readiness to use and apply digital technology? and (3) What is the relationship between lifelong learning attitudes, digital readiness, and perceived industry-aligned competencies? The present study employs a quantitative research design, whereby the data were collected via a structured questionnaire survey distributed to final-year students from various academic departments using stratified sampling. The statistical data analysis will involve descriptive statistics, reliability testing, correlation, and regression to determine the strength and significance of the relationship between the constructs. The empirical findings demonstrate that lifelong learning attitudes and digital readiness significantly influence the development of learner competency aligned with industry needs. This study is expected to balance the interventions' needs, which can nurture a culture of continuous learning and digital skills among the polytechnic students. In line with the constructive framework of TVET 360° empowerment, this research study has the potential to contribute to transforming of the technical and vocational education system, offering practical implications for educators' administration and policymakers.

Keywords: Digital Technology Readiness, Industry-aligned Competency, Lifelong Learning, Polytechnic Students, Student Empowerment

1.0 Introduction

The Fourth Industrial Revolution (IR4.0) has completely changed the global employment scenario, making it necessary for TVET institutions to supply graduates who not only have technical skills but are also digitally literate and embrace the life-long learning attitude (Charles et al., 2025). Malaysia Policies, such as the TVET Empowerment Plan (2021-2025) and the Twelfth Malaysia Plan, encourage polytechnics to include these in their learning services, to develop graduates who will meet the future (Economic Planning Unit., 2021).

Lifelong learning refers to a continuous process in which individuals acquire knowledge and skills through self-directed learning and personal motivation. Lifelong learning makes learners more malleable and employable (Saari et al., 2025). At the same time, digital preparedness as the capacity and desire to use digital technologies in practice, has become a requirement of moving around industrial landscapes of this century (Matt, et al., 2023).

However, despite these national agendas, there has remained a persistent gap between graduate capabilities and the requirements of industries. Recently, it has been estimated that many graduates of Technical and Vocational Education and Training (TVET) require digital competencies and struggle to apply autonomously in the real world (Hassan et al., 2021; Rajamanickam et al., 2024). This issue is documented during the initial notes of Politeknik Tuanku Syed Sirajuddin, reflecting this concern, revealing variation in students' digital engagement and learning independence. Others are relatively active responsive and continue with traditional instruction. This gap means that there is a deeper issue of inconsistent readiness, which is at both the psychological and technological levels and may create an obstacle to obtaining industry-specific skills (Li, 2024).

Further complicating the problem is the limited empirical studies connecting the internal dispositions of students' lifelong learning attitudes, regarding their preparedness in digital readiness, to their perceived skills in competency building (Yaacob et. al., 2024). Hence, the research aims to investigate the extent of lifelong learning attitudes and digital readiness among final-year polytechnic students and the roles of these factors in perceptions of ability to achieve industry expectations.

This study pursues three objectives: to examine the students' attitudes toward lifelong learning, assess their readiness to use digital technologies, and to determine how the two above variables are associated with the development of industry-aligned competencies. Research questions are correspondingly created and aim to question the degree of such attitudes and preparedness and the manner of their interrelation with competency outcomes. Specifically targeting final year students in different departments in Politeknik Tuanku Syed Sirajuddin, the research takes on a quantitative method with structured questionnaires.

The results will assist in revising curriculum design, guide policy trends and support the overall objective of producing comprehensive, future-thinking graduates. Based on its proposed TVET 360° Empowerment Model, this study theoretical and practical implications for enhancing human capital development in Malaysia regarding lifelong learning and digital empowerment.

2.0 Literature Review

This literature review in the study aims to investigate the primary constructs, which the conceptual framework of the proposed research is based on: lifelong learning attitudes, digital readiness and industry-aligned competencies. Those constructs play an essential role in realizing how both the psychological and technological forces affect graduate preparedness in the context of the Technical and Vocational Education and Training (TVET) in Malaysia. The study critically synthesises past empirical and conceptual studies that aim to set the theoretical foundations on which the study revolves. The subsection is devoted to the discussed construct, an overview of the existing research findings and the identification of research gaps and limitations in the context of the Malaysian polytechnic. The review ends by formulating of a conceptual framework and a set of hypotheses that lead to the empirical part of this research.

2.1 Lifelong Learning in TVET Context

Lifelong learning has been a well-recognised essential component in transforming graduates to face the changes and uncertainties of the job market in the IR4.0 world (Saari et al., 2025; Friedman, 2023). Considering the Malaysian TVET, there have been attempts to incorporate lifelong learning skills in curriculum development and student training. Such competencies include self-directed learning, flexibility, and an active approach towards learning (Rajamanickam et al., 2024). According to research by Yaacob et. al., (2024) and Nurjanah & Ana, (2022), the better prepared a student is before lifelong learning, the more resilient and employable the TVET student will be. Although it enjoys policy focus, numerous studies are conceptual without a credible empirical test with student-specific TVET samples.

Despite the high policy focus on the concept of lifelong learning, as proposed in the Twelfth Malaysia Plan 2021- 2025 (Economic Planning Unit., 2021) Most studies on the topic are merely conceptual and policy-oriented and lack an actual examination of samples of students in TVET institutions (Charles et al., 2025; (Mastor et. al., 2021). This shows that a research gap has yet to be filled regarding the complex construct of lifelong learning, which requires more empirical support in the Malaysian polytechnic setting.

2.2 Digital Readiness among Polytechnic Students

In academic or industrial environments, digital readiness is described as the capability and confidence to embrace and employ digital technologies (Holmström, 2022). The disparity in the extent of digital preparedness of students of TVET education has not been consistent, with inequity being perpetuated by the type of programme, digital exposure, and institutional support (Yaacob et al., 2024; Matt et al., 2023). The pandemic of the coronavirus infection COVID-19 has pushed digital transformation to a new level, but there are still several students who display cases of passive consumption of technology or surface-level engagement (Charles et al., 2025).

There are also reports of digital readiness issues in studies, but few have directly connected these with competency development (Nurjanah & Ana, 2022; Rajamanickam et al., 2024). Additionally, most studies fail to differentiate

between digital access and digital competence, culminating in simplistic conclusions regarding the level of preparedness (Saari et. al., 2025).

2.3 Industry-Aligned Competency in TVET Graduates

Competencies aligned to the industry are not limited to technical expertise and skills, but include soft skills and digital literacy, problem-solving and workplace adaptability (Friedman, 2023). It has been proven through literature that the failure to align the Technical and Vocational Education and Training (TVET) curriculum with the industry needs often results in the underemployment of graduates (Ibrahim & Nashir, 2022). The employers have repeatedly expressed a desire for graduates who can work in multidisciplinary teams, successfully manage digital-intensive business processes, and be responsive to constant organisational change (Someh et al., 2023).

Nevertheless, it seems that implementation in polytechnics in Malaysia has broken down, and few broad-based competency frameworks are available. Empirical research often relies on mechanisms employed by the employer without paying attention to the students' opinions on their readiness.

2.4 Relationship between Lifelong Learning, Digital Readiness, and Competency

In recent academic research, digital readiness and the mutual impact of lifelong learning attitudes have been presented as an essential lever of student strength. The recent results support the assertion that both constructs are essential in a considerable way in shaping academic performance (Mehrvarz et al., 2021). However, existing empirical evidence is more inclined to consider these variables separately and, therefore, fails to account for their overall impact on the learning path. Thus, an integrative model is a necessity for the field.

Lifelong learning is a process that enables constant adaptation. Digital readiness, on the other hand, strengthens learners' capacity to apply acquired knowledge effectively within technology-mediated practices (Demir et al., 2022). Factually, an empirical literature has so far only done work with advanced analysis methods about precisely presenting this interrelationship, most especially through PLS-SEM (Hidayat-ur-Rehman, 2024). Besides, available research often ignores the related theories, especially Self-Determination Theory and the Digital Competence Framework (DigComp) (Chaw & Tang, 2024).

2.5 Theoretical Foundations

This study combines both theory-oriented perspectives that are complement each other, which are constructivist learning theory and the TVET 360° Empowerment Framework. Constructivism asserts that learners, through experience, reflection, and the use of digital media, construct knowledge, which emphasises the value of lifelong learning, as well as the utility of digital tools (Efgivia et al., 2021). The TVET 360° concept implies that implies that the psychological variables, such as learning attitudes, should be prioritised along with technology variables, such as digital readiness, as key determinants of holistic graduates.

While constructivism is greatly appreciated in the academic field, its use in a polytechnical setting is relatively understudied. TVET 360° Empowerment Framework is a new and more thorough effort to implement constructivist principles in the form of operationalisation in these environments. Still, without vigorous empirical testing, the extent to which these concepts can be applied remains unidentified.

2.6 Research Gap

It remains consistent among the literature to implicate life-long learning and digital readiness as the defining feature of a higher education institution and training potential employable workforce. Still, rather limited empirical research examines converging implications on industry-relevant competencies, particularly in the Malaysian TVET system. Current research focuses normally on each one of these parameters separately, and a more minor concern is about their interactive relationship to professional efficacy among polytechnic students (Chen et al., 2024). The current research eliminates these gaps by theorising psychological and technological preparedness as a single construct and testing its explanatory potential by using an empirical study.

3.0 Methodology

The chapter outlines the methodological approach that was used to examine the relationships between lifelong learning attitudes and digital readiness as antecedents of industry-aligned competencies among polytechnic students. The study employed a quantitative design, providing a structured and systematic analytical procedure for testing the hypotheses developed from the conceptual framework. This study followed a six-phase methodological framework, as illustrated in Figure 1, to ensure that the research process was conducted systematically and coherently from problem identification to reporting. The six phases used in this study were adapted from the structured research process proposed by Creswell and Creswell (2018), which emphasises methodological coherence and rigour.

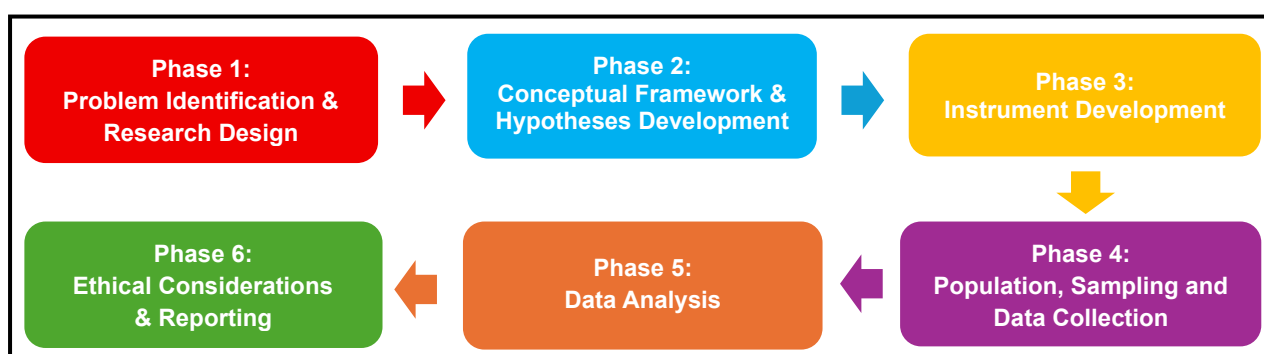


Figure 1: Six-Phase Methodology Framework

3.1 Problem Identification and Research Design

The study discusses the gap between the competencies of polytechnic graduates and the demands of the industries in the times of the digital revolution. The state policies promoting lifelong learning and building personal expertise in digital basics have not shown an adequate level of preparedness, especially

regarding autonomous training and the readiness to switch to innovative technologies. Surveys used in Politeknik Tuanku Syed Sirajuddin also disclosed an inconsistent engagement pattern, thus displaying a two-fold dilemma based on the mental preparedness and technological competency.

A quantitative research approach based on structured questionnaires was deployed to illuminate these findings. This plan can help in hypothesis testing through statistics and is aligned with the TVET 360° Empowerment Model, which focuses on empowering learners through their attitudes towards lifelong learning and digital readiness. The outcome of the interpretation of such data can be used to review the curriculum and formulate policies.

3.2 Conceptual Framework & Hypotheses Development

The study is framed in terms of a constructivist learning theory based, in part, on the TVET 360° Empowerment Model which identifies psychological and technological readiness as critical factors relating to a student's competency. Lifelong learning attitudes (LLA) reflect an intrinsic drive that characterises a willingness of learners to be continuously self-developed, and digital readiness (DR) implies the ability to use digital tools and resources. The study hypothesises that the two constructs work synchronously to increase achievement of industry-aligned competencies (IAC).

According to the TVET 360 Empowerment Model, the conceptual framework illustrated in Figure 2 focus on the lifelong learning attitudes and digital preparedness as a dual-predictor of industry-aligned competency. Based on this framework, two hypotheses were developed that were to be used to conduct the empirical study:

H1: Lifelong learning attitudes have a positive influence on industry-aligned competencies.

H2: Digital readiness has a positive influence on industry-aligned competencies.

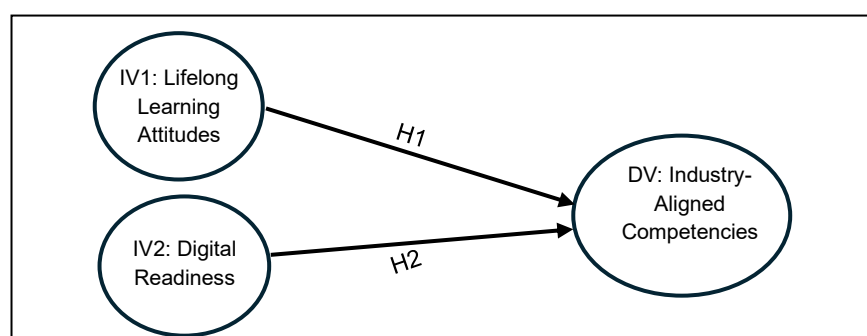


Figure 2: Conceptual Framework of the Study

This dual-dimensional model is based on the idea of student empowerment as the convergence of mindset and skill set in the reaction to the needs of IR4.0 and the inherent goals of the Malaysian TVET transformation agenda.

3.3 Instrument Development

In this study, a comprehensive questionnaire was created with assessment items from previously validated instruments in lifelong learning attitudes, digital readiness, and industry-aligned competencies. The instrument's design was adapted and modified from prior research, including (Mehrvarz et al., 2021) on digital readiness, (Nurjanah & Ana, 2022) on industry-aligned competencies, and (Demir et al., 2022) on lifelong learning tendencies. The items were enhanced to embody the comprehensive and forward-looking characteristics of TVET education and graduate employability. The gathered data were examined via SPSS software, applying descriptive and inferential statistics. The study employed descriptive analysis, reliability assessment using Cronbach's Alpha, correlation analysis through Pearson's coefficient, and multiple regression modelling, adhering to the analytical methodologies established by Pallant (2020) and Field (2024).

3.4 Population, Sampling, and Data Collection

The study population used included final year diploma students in different academic departments of Politeknik Tuanku Syed Sirajuddin. A stratified sampling method was used to facilitate proportional representation due to a wide range of diversity, such that the findings can be generalised within the polytechnic setting.

The sample size was considered adequate for the quantitative analyses conducted in this study, particularly descriptive analysis, reliability testing, correlation analysis, and multiple regression. Based on the general guideline for multiple regression, the minimum sample size can be estimated using $N > 50 + 8m$, where m represents the number of predictors (Green, 1991). Since this study involved two predictors, namely Lifelong Learning Attitudes and Digital Readiness, the minimum recommended sample size was 66 respondents; therefore, the final sample of 75 valid respondents was considered acceptable.

The study achieved the proposed model's recommended sample size, consisting of two exogenous (Lifelong Learning Attitudes and Digital Readiness) and one endogenous construct (Industry-Aligned Competency) with the final sample of 75 valid respondents. Online data was collected depending on accessibility. Participation was entirely voluntary, and informed consent was taken before distribution. Treatment of the responses was strictly confidential and could only be analysed academically.

3.5 Data Analysis

Statistical application tools to analyse the data, such as descriptive analysis, reliability testing (Cronbach Alpha), correlation analysis, and regression analysis, were conducted on data collected on the questionnaires. Each construct was summarised using descriptive statistics, mean, and standard deviation. Cronbach's Alpha was used to measure internal consistency, and all constructs surpassed the 0.70 mark, measuring measurement stability.

In testing the hypotheses, Pearson correlation and multiple regression were performed to establish the strength and predictive power of the attitudes

towards lifelong learning and digital readiness to industry-aligned competencies. This methodology of a two-fold approach was taken explicitly so that the findings are robust in terms of the topic, given that it is an exploratory study, and the sample size is small to medium. Collectively, these analyses confirmed the conceptual framework and defined the role of psychological and technological preparedness towards shaping student competencies.

3.6 Ethical Considerations & Reporting

This study examined the ethical research principles institutions uphold across all facets of research. The participants volunteered and were informed of all key objectives of the study, the purpose of the data collection, and their right to withdraw at any time without penalty. No personally identifiable information was collected, and all responses were strictly confidential. Informed consent was obtained before. Information was recorded in both the hard and online questionnaires. The institutional research ethics committee approved the research protocol, ensuring compliance with ethical principles of autonomy, beneficence and data protection. The report presents strictly empirical findings and interprets them within the constraints of the established research framework.

4.0 Results and Discussion

This section utilised recognised quantitative research approaches for analytical procedures to guarantee statistical validity and interpretive rigour. Descriptive statistics were employed to encapsulate response patterns and distribution across the study constructs, adhering to the guidelines set forth by Creswell and Creswell, (2018) for the presentation of quantitative data. The constructs' reliability was evaluated using Cronbach's Alpha, with values above 0.70 deemed acceptable for internal consistency, as specified by Hair et al., (2022). Pearson correlation analysis was performed to examine the strength and direction of inter-variable connections, adhering to the principles established by Pallant, (2020). Additionally, multiple regression analysis was conducted to assess the predictive capacity of the independent variables Lifelong Learning Attitudes and Digital Readiness on Industry-Aligned Competency, utilising principles from Field, (2024) to interpret regression coefficients, R^2 values, and model significance. Collectively, these analyses provided empirical support for assessing the conceptual framework presented in this paper.

4.1 Descriptive Analysis of Demographic Profile of Respondents

Table 4.1: Demographic Profile of Respondents

Demographic Variable	Frequency (n)	Percentage (%)
Gender (Male)	19	25.3
Gender (Female)	56	74.7
18 – 20 years	73	97.3
21 – 23 years	2	2.7

Table 4.1 shows the demographic profile of the respondents. The sample size consisted of 75 final-year students, who were a representative cross-section of the polytechnic and were selected by representing a wide variety of academic

departments. The gender status demonstrated that an estimated 74.7% were female, and 25.3% were men, which implied more female enrolment than male. Underage, 97.3 % of the respondents were between the 18-20 years group, which shows that they are still at an early stage in tertiary education.

The demographics indicate a balanced gender distribution with a majority in the 21–23 age group. Most respondents are from ICT and engineering departments, with high levels of technology usage and engagement in self-directed learning key attributes that support readiness for digital education and industry integration.

4.2 Descriptive Analysis of Core Study Constructs

Table 4.2: Descriptive Statistics for Core Constructs

Construct	Mean	SD
Lifelong Learning Attitudes (LLA)	4.15	0.4456
Digital Readiness (DR)	3.98	0.5013
Industry-Aligned Competency (IAC)	3.95	0.4660

Table 4.2 presents the descriptive statistics for the three primary constructs. Every construct was evaluated according to eight questions arranged on the five-point Likert scale all constructs measured above 3.90, which illustrates that mostly students perceived positive results. Values of standard deviations were all relatively small and were all under 0.51, indicating very little variation across items and indicating that most respondents shared similar views in each construct.

The LLA recorded the highest mean ($M = 4.15$), which is positive, showing a strong agreement with statements about self-directed learning, motivation and continuous improvement. The Digital Readiness ($M = 3.95$) also showed a positive result as the students felt quite confident and competent to use digital tools. Likewise, the mean rating of Industry-Aligned Competency ($M = 3.95$) indicates that students feel moderately adequately prepared to fulfil industry expectations. On balance, the results show a favourable alignment of the readiness profile along the psychological, technological, and competency axes of the TVET 360° Empowerment model.

4.3 Reliability Analysis of Constructs

Table 4.3: Reliability Coefficients (Cronbach's Alpha)

Construct	No. of Items	Cronbach's Alpha (α)	Interpretation
Lifelong Learning Attitudes (LLA)	8	0.851	Excellent
Digital Readiness (DR)	8	0.886	Excellent
Industry-Aligned Competency (IAC)	8	0.874	Excellent

Cronbach's Alpha was used in the reliability analysis of the internal consistency of each construct. The standard criterion of reliability is usually 0.70 and above, implying that items of each construct yield a similar dimension over time. The

coefficients of reliability of the three core constructs have been summarised in Table 4.3.

The internal consistency of all three constructs was excellent, with Cronbach's alpha values between 0.851 and 0.886. That means the items that comprised the questionnaire to measure lifelong learning attitudes, digital readiness, and industry-aligned competencies were statistically reliable and suitable for further inferential analysis.

4.4 Relationship between LLA, DR, and IAC (Correlation Analysis)

Table 4.4: Pearson Correlation Matrix

Variables	LLA	DR	IAC
Lifelong Learning Attitudes (LLA)	1	0.679**	0.756**
Digital Readiness (DR)	0.679**	1	0.797**
Industry-Aligned Competency (IAC)	0.756**	0.797**	1

Note: The level of correlation is significant at the $p = 0.01$ level (2-tailed).

The Pearson correlation analysis was conducted to study the intensity and direction of the relationships of the key variables of the study, Lifelong Learning Attitudes (LLA), Digital Readiness (DR), and Industry-Aligned Competency (IAC). As Table 4.6 indicates, every correlation coefficient was determined to be significant and positive at the 0.01 level (2-tailed).

The strongest correlation was found between Digital Readiness (DR) and Industry-Aligned Competency (IAC), which were strongly positive ($r = 0.797$, $p < 0.001$). This implies that students who are digitally more ready will feel more qualified than those who are accustomed to the demands of the industry. The LLAs, as well, were highly correlated with IAC ($r = 0.756$, $p < 0.001$), meaning that students with high self-directed learning trends would be more inclined towards feeling in line with what the industry requires of them. Also, the correlation between LLA and DR (0.679) predicts a weak relationship between psychological and technological readiness.

4.5 Influence of LLA and DR on IAC (Regression Analysis)

Table 4.5: Regression Analysis (DV = IAC)

Predictor	β	t-value	Sig. (p)
LLA	0.397	4.682	<.001
DR	0.528	6.219	<.001
R ²	0.721		
Adjusted R ²	0.731		
F-value		93.013	<.001

Table 4.5 shows the multiple regression analysis results calculating the dependent effect of the Lifelong Learning Attitudes (LLA) and Digital Readiness (DR) variables on Industry-Aligned Competency (IAC).

The regression model indicates that LLA and DR are significant predictors of IAC, although the effect of DR ($\beta=0.528$) is greater than that of LLA ($\beta=0.397$). Its $R^2 = 0.721$, which implies that the model shows 72.1% of the variance in IAC, and its adjusted $R^2 = 0.713$ shows that the model is very accurate. The significance of the model's overall fit is established by the F-statistic (93.013, $p < .001$).

4.6 Comparison with Previous Studies

This study's findings support prior research indicating that Lifelong Learning Attitudes (LLA) and Digital Readiness (DR) are substantial predictors of Industry-Aligned Competency (IAC), aligning with the studies of (Mehrvarz et al., 2021) and (Demir et al., 2022) which emphasised the favourable correlation between digital competence, autonomous learning, and performance outcomes. The robust association between digital readiness (DR) and industry-academic collaboration (IAC) ($r = 0.797$), together with its significant regression coefficient ($\beta = 0.528$), corroborates the assertions of (Matt et al., 2023), who posited that digital readiness is a pivotal determinant of graduate employability in the Industry 4.0 environment. This study fills the research gap indicated by (Chen et al., 2024) By integrating psychological and technological characteristics into a unified empirical framework, the TVET 360° Empowerment Model, unlike past studies that studied these constructs in isolation. Consequently, the findings corroborate current literature and significantly enhance the comprehension of how to develop comprehensive, adaptive, and industry-prepared TVET graduates.

5.0 Conclusions

This study shows that Lifelong Learning Attitudes (LLA) and Digital Readiness (DR) significantly impact the development of Industry-Aligned Competency (IAC) in final-year polytechnic students. The multiple regression analysis validated both hypotheses, indicating that Digital Readiness ($\beta = 0.528$) has a marginally greater predictive influence than LLA ($\beta = 0.397$). The model explained 72.1% of the variance in IAC ($R^2 = 0.721$), demonstrating substantial explanatory power and underscoring the significance of psychological and technological readiness in aligning TVET graduates with the demands of the changing industrial environment.

These findings provide empirical data to the discussion on TVET reform, presenting practical consequences for curriculum authors, institutional leaders, and policymakers. Polytechnic institutions should integrate self-directed learning methodologies and digital literacy modules into all academic programs to improve students' comprehensive preparedness. Its sample size and cross-sectional methodology constrains the study's generalisability; therefore, future research should encompass multi-institutional, longitudinal investigations and employ mixed-method approaches to more effectively elucidate the dynamic interactions among LLA, DR, and IAC. Creating structured intervention models based on the TVET 360° Empowerment framework could enhance the strategic transformation of Malaysia's technical and vocational education system.

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Author Contributions

N.E. Mat Nasir Conceptualisation, Literature Review, Formal Analysis, Manuscript Writing; **A. Awang** Data Collection, Reviewing, Editing, Proofreading; **N. Mat Nasir** Reviewing, Manuscript Refinement; **E. Syam** Reviewing.

Conflicts of Interest

The manuscript has not been published elsewhere and is not under consideration by other journals. All authors have approved the review, agree with its Submission and declare no conflict of interest in the manuscript.

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